Department of Engineering & Design

University of Sussex

Industrial Informatics & Signal Processing Research Group *(iisp)* 1995 -2015

Professor Chris Chatwin

Dr Rupert Young – Reader

Dr Phil Birch – Senior Lecturer

Dr Tai Yang – Reader

Celebrating 50 years of engineering at Sussex

24th April 2015

Summary

University of Sussex

- Research feeds our teaching
- Topics covered
  - Micro and nano manufacture
  - Texrad – medical image processing – spinout
  - Fluorescence microscopy
  - Biometrics
  - Security – target tracking
- Active Topics not covered
  - Healthcare informatics, Big data, Smart cities, Smart grids, Networks, Mathematical Modelling

Research Collaborations and Exchanges with 26 Countries

University of Sussex

iisp Graduated 51 Doctoral Students from 27 Countries

University of Sussex

Our Research Feeds into our Teaching

University of Sussex

- **MSc/ and 4th year MEng, BEng 3rd year: 2015**
  - Cybernetics and Neural Networks; 15 credit course
  - Advanced Manufacturing Technology; 15 credit course
  - Fibre Optic Communications; 15 credit course
  - Satellite & Space Systems; 15 credit course
  - Advanced Digital Signal Processing; 15 credit course
  - Image Processing; 15 credit course
  - Advanced Electronic Systems; 15 credit course
  - Power Systems; 15 credit course
  - Electronics Technology; 15 credit course
  - Computer Networks; 15 credit course

Some statistics

University of Sussex

- Grants and contracts ≋ £10 million - EPSRC, EU, Industry
- Journal papers: 295
- Books: 2
- Book chapters： 17
- Refereed conference papers： 325
- Professional memberships:
  - IET, IEEE, IOP, OSA, EOP, BCS, ACM, IMechE

Hirsch h-index

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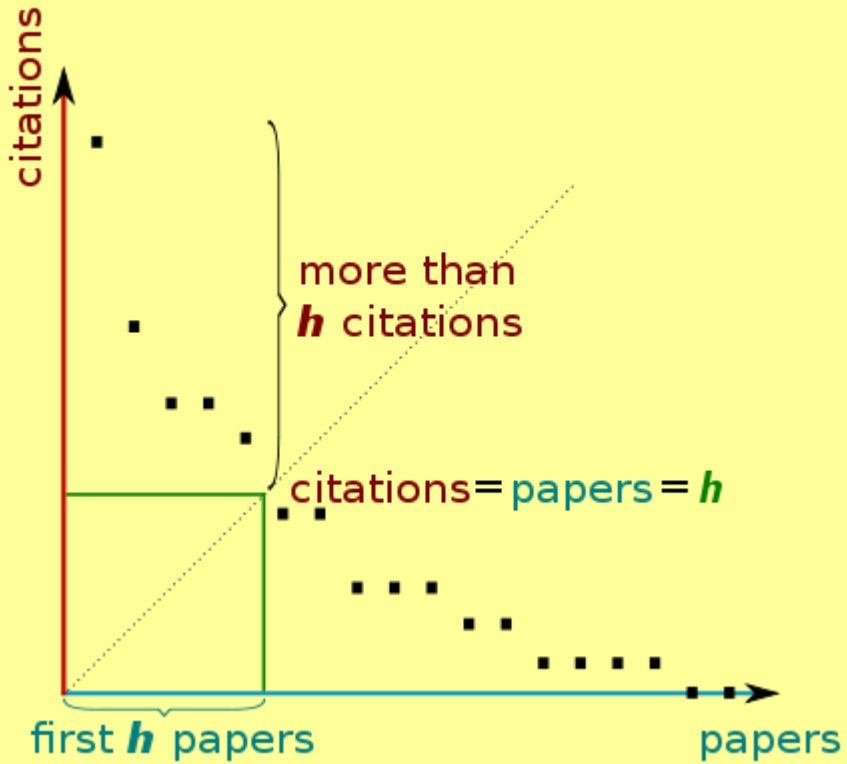

Professor Chris Chatwin – h#24
Dr Rupert Young – Reader – h#21
Dr Phil Birch – Senior Lecturer – h#14
Dr Tai Yang – Reader – h#22

The ***h*-index** is an index that attempts to measure both:
the productivity and citation impact of the published body of work of an engineer, scientist or scholar.

UV Microstereolithography System Diagram 1996 – 2001 EPSRC & EU[1], [2]

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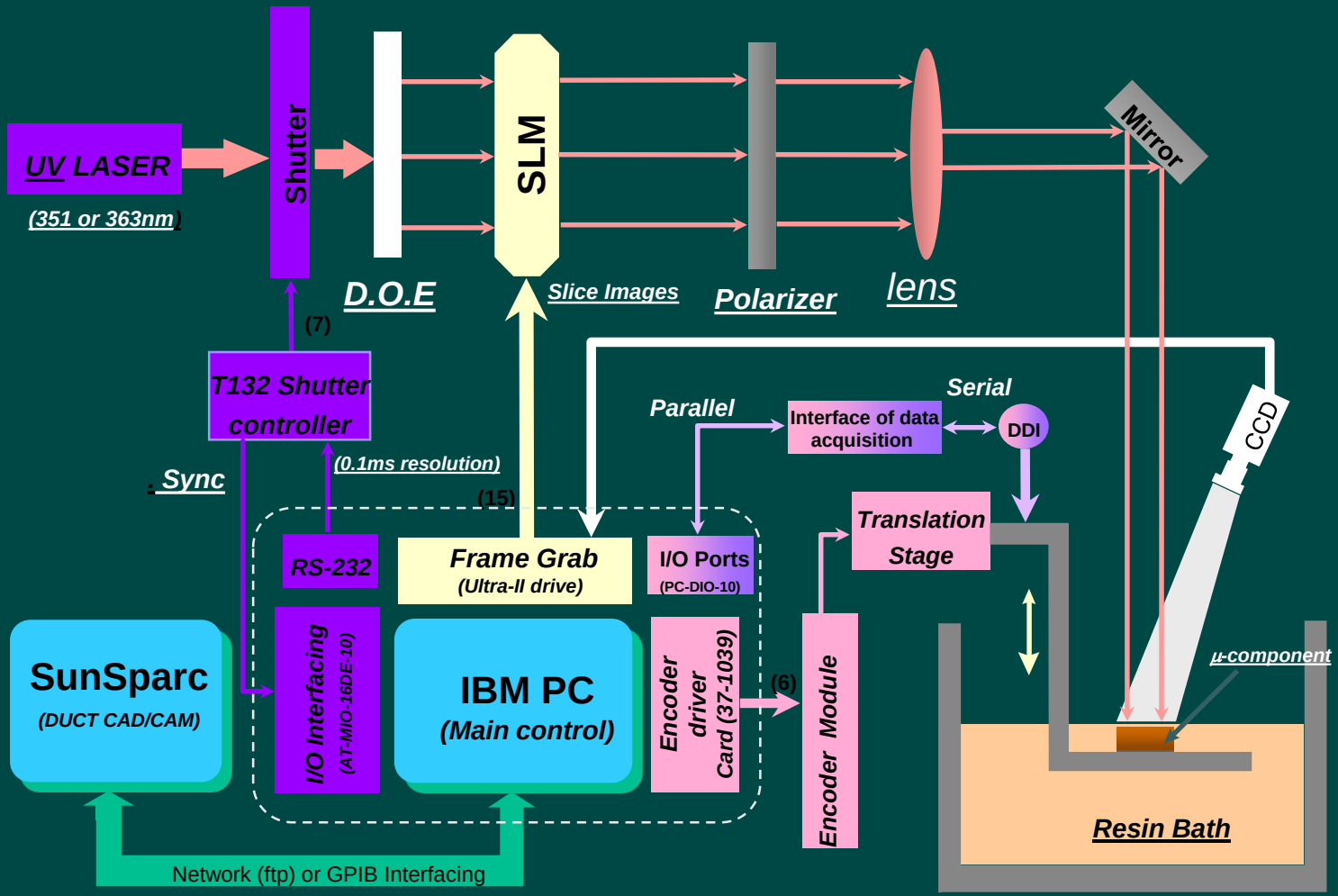

Spatial Light Modulator (SLM)

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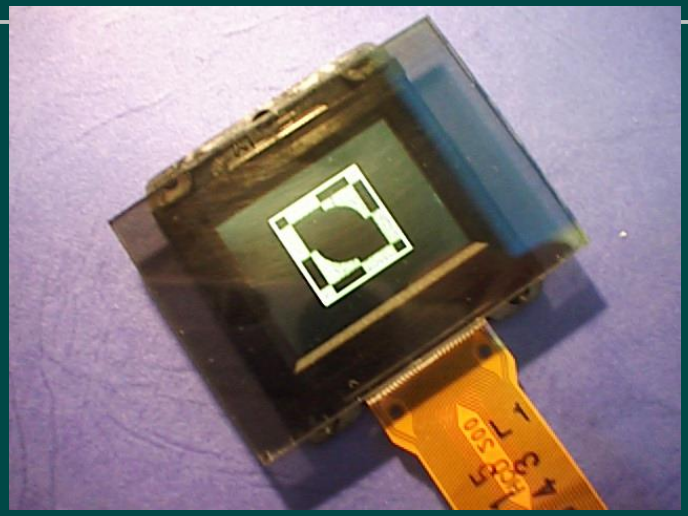
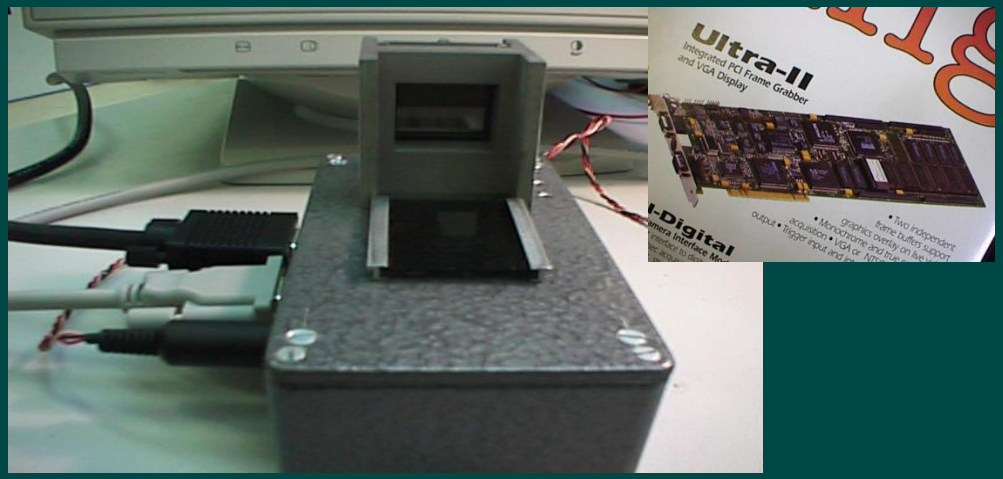


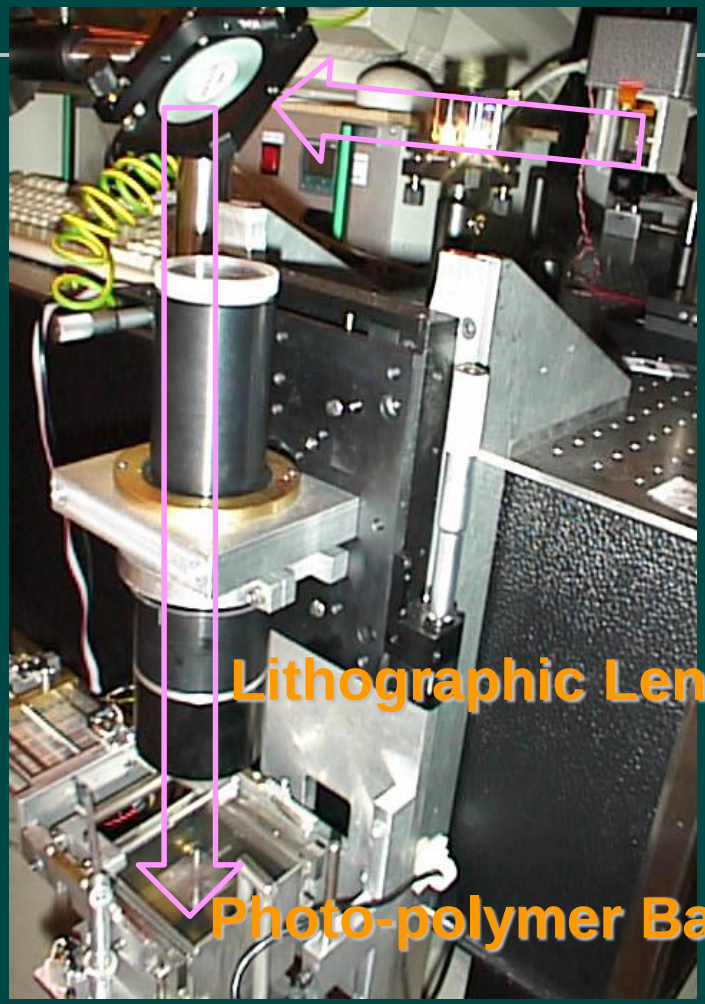
SVGA SLM 800x600 pixels



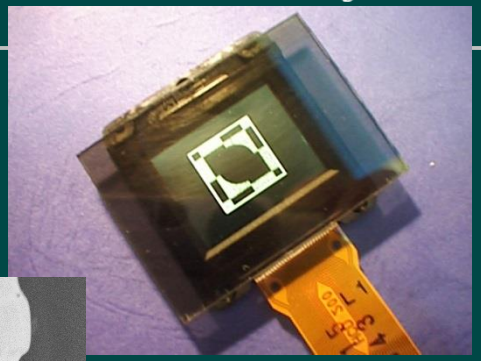
- Features
- VGA and SVGA
- Ultra-II PCI Frame Grab with video and VGA Frame buffers (2Mb each)
- CCIR/PAL camera
- Overlay display

Micro-component Prototyping

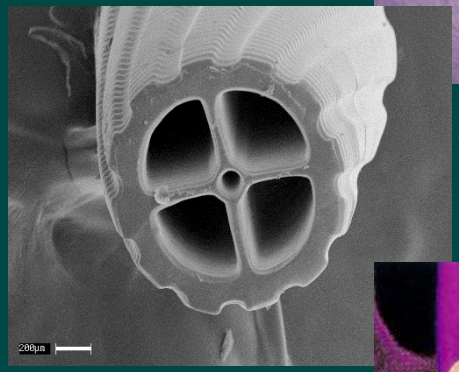
University of Sussex

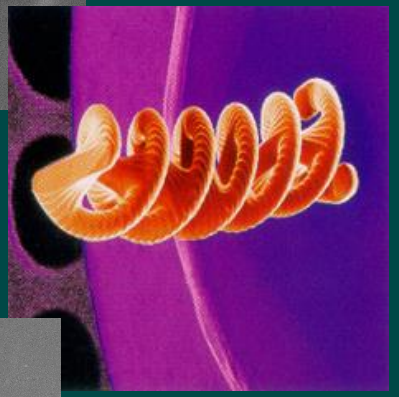


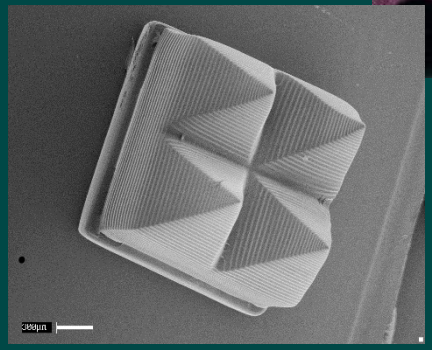
Microstereolithography System



SVGA SLM 800x600 pixels







UV light path

Main Programme Control Panel

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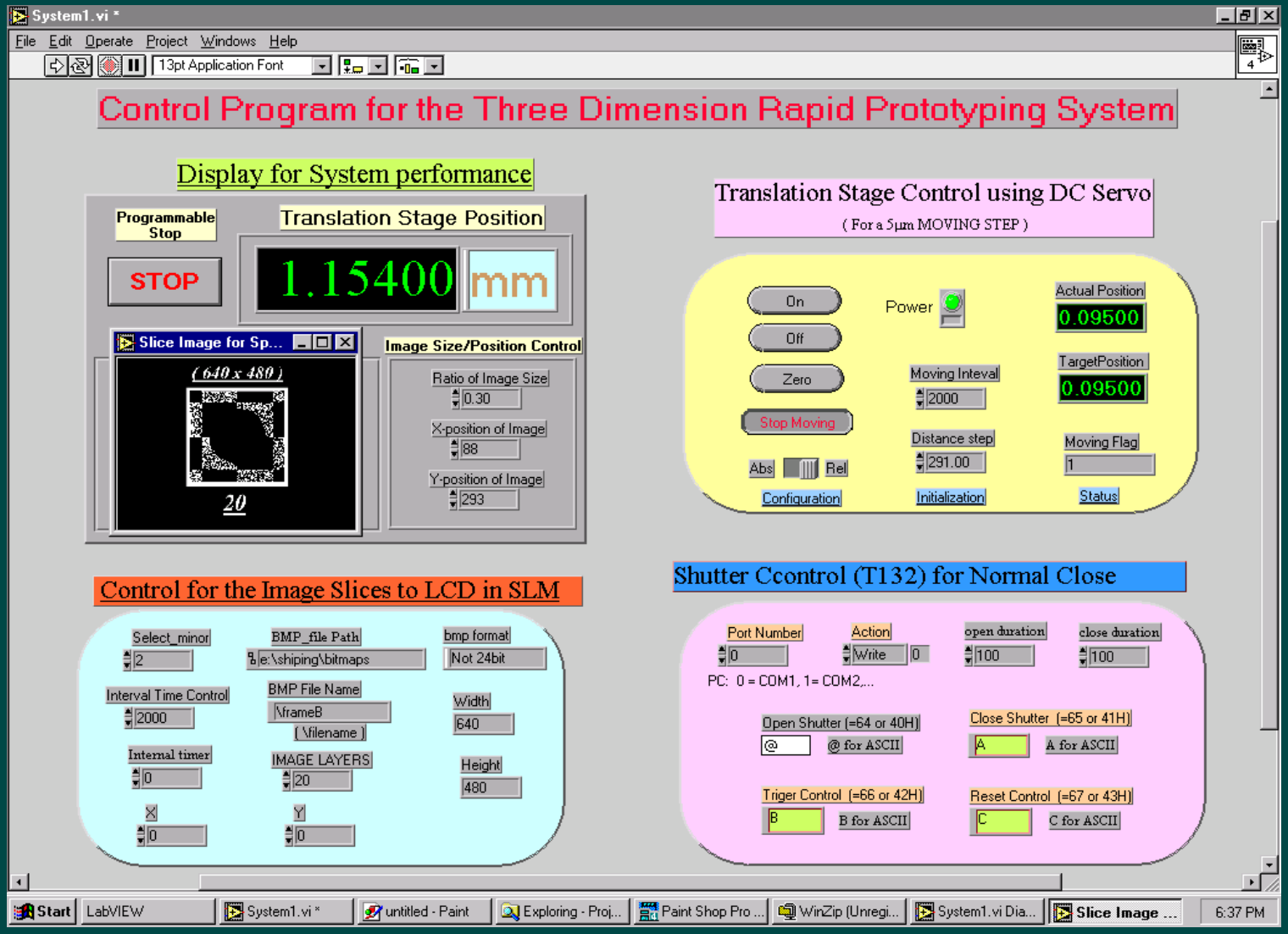

MicroSLA System

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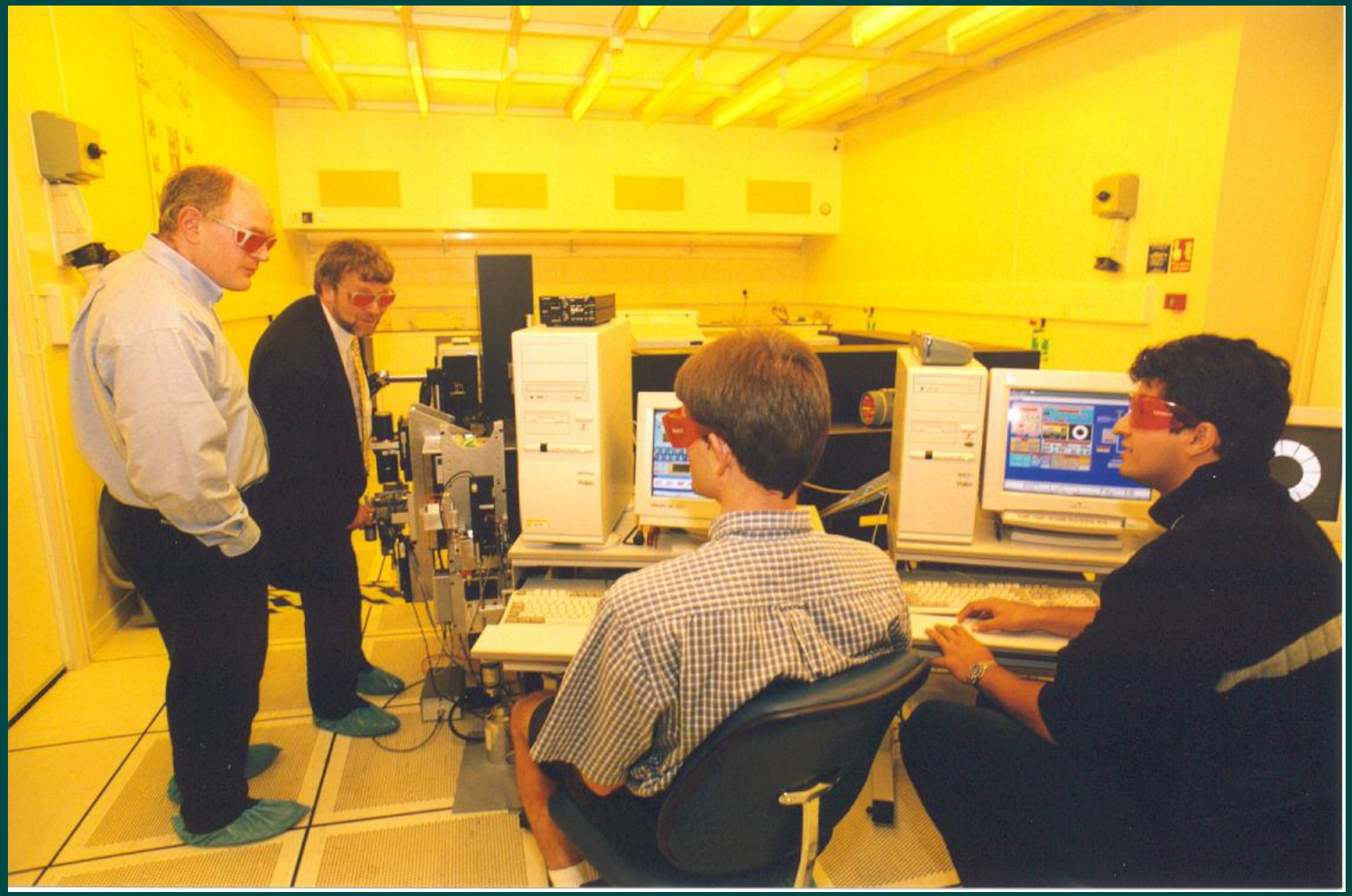

Micro-components built using 351nm UV

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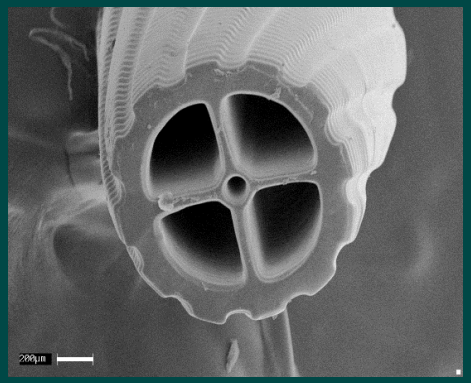
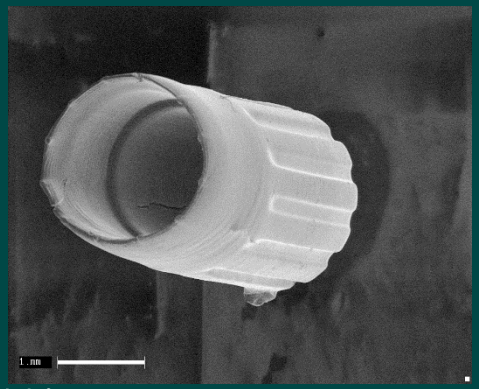
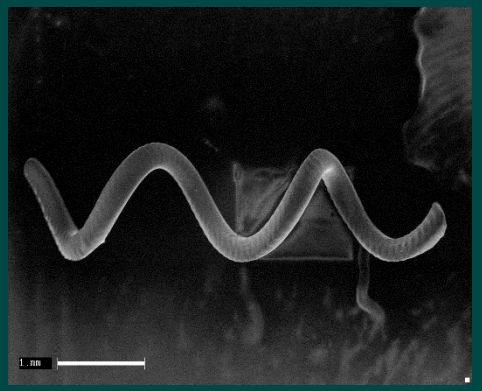


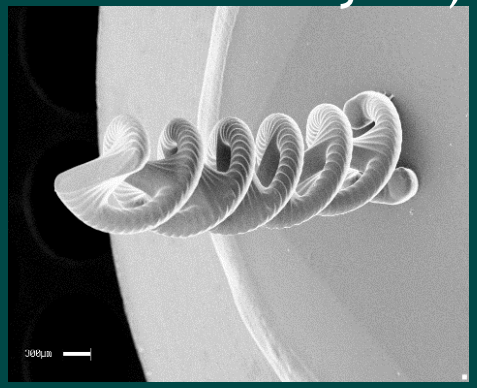
A micro-gear (50 micron layers)



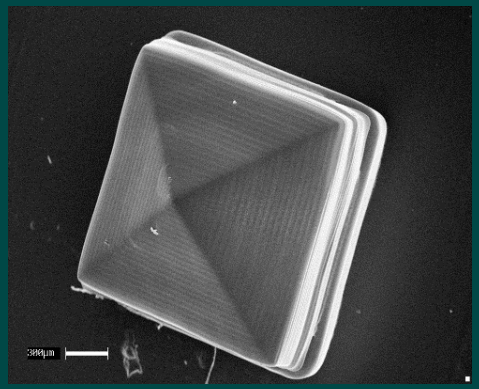
Micro-motor case (50 micron layers)



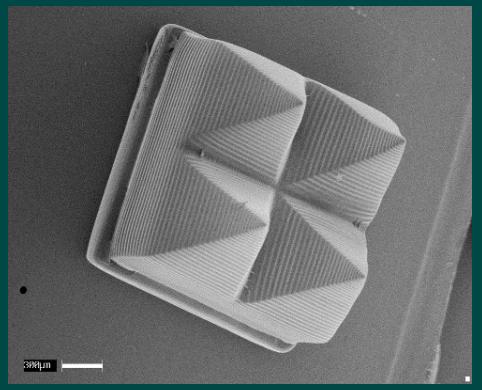
A helix (50 micron layers)



Double helix (50 micron layers)



Micro-pyramid (35 micron layers)



Micro-pyramids (50 micron layers)

Micro-fabrication for micro-robots

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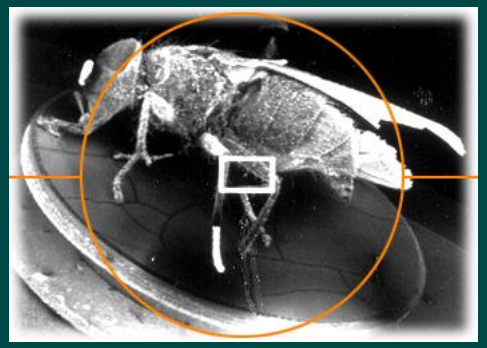
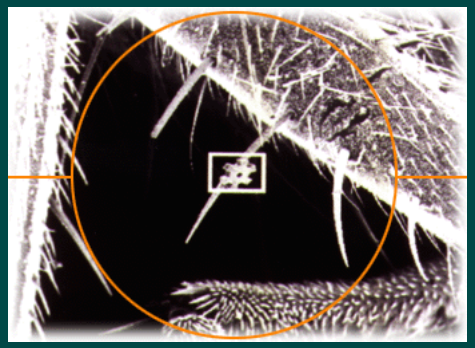
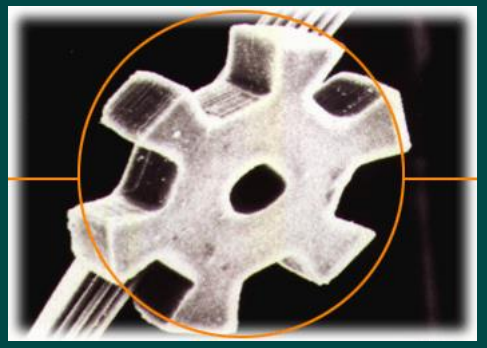




Gear 50 microns diameter



Achievements

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- A new micro-stereolithography process was developed
- It operates in the UV
- It used an SLM as a dynamic lithographic mask
- We can manufacture micro-parts which are complex in shape that could not be manufactured with either conventional stereolithography or silicon processing methods
- The build time is 30 seconds per layer, with further optimisation this time will be reduced
- Our system is built components with a 5 micron layer thickness

Cell sac, fabricated employing a point-by-point MPP of an organic-inorganic material

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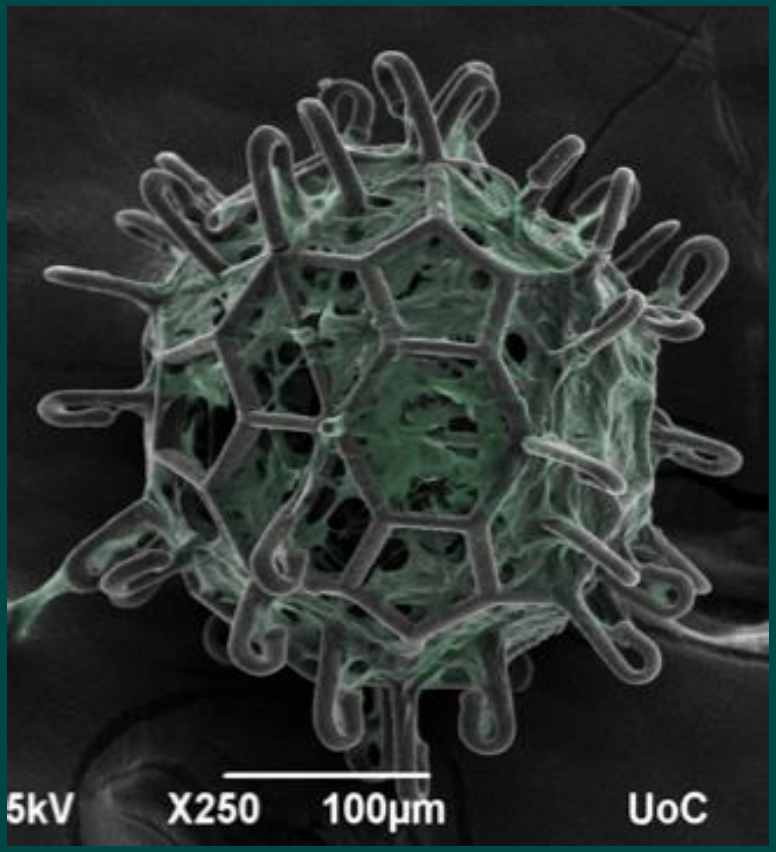

Courtesy of Maria Farsari

HOLOGENESIS will pursue vascular regeneration – 2015 EU pending

It will demonstrate the fabrication of a shape-controlled 3D Elastin-like Recombinamers (ELRs) platform that can be tuned to modulate angiogenic paracrine responses of adult stem cells.

Traditional MPP is slow, as it relies on a point-by-point scanning system. Holographic 3D printing will solve this issue; 100nm resolution is possible

Medical Image Processing – TexRAD Impact Case study – 2008 onwards

University of Sussex

- Research to address the detection of weak structured signals from within highly variable cluttered imagery, originally for vehicle tracking, is being used to identify textural variations in organ tissue. （vehicle tracking later in presentation）
- The technology was spun out into a company, TexRAD Ltd in 2011.
- On Friday 16 May 2014 TexRAD was one of two companies bought by Feedback plc, an AIM-listed company specialising in medical imaging tools.

TexRAD can use existing data

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- The TexRAD software has workstation, server and cloud-based versions.
- The clinical evidence generated was sufficient for the first stage of the FDA (USA) and CE (Europe) approvals process ISO-13485 quality and FDA/CE approval expected in 2015.
- TexRAD's texture analysis is a relatively inexpensive and simple process by which tissue abnormalities, and hence prognosis, treatment plans and response to treatment, can be monitored and acted upon without invasive procedures or further images being required.

TexRAD was reversed into Feedback plc - market capitalization – £3.15 Million

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FDBK FEEDBACK PLC ORD 0.25P

FEEDBACK Currency GBX

SUMMARY | INTERACTIVE CHART | PRICES AND TRADES | FUNDAMENTALS | TECHNICAL ANALYSIS | NEWS ANALYSIS | NEWS

Price	High	Low	Volume	Last close	+/-	Var %
1.65	1.65	1.48	507,896	1.65 on 17-Apr-2015	▲+0.18	+11.86%

As at 19-Apr-2015 19:58:29 - All data delayed by at least 15 minutes.

Bid	1.50
Offer	1.80
Trading status	Market Close
Special conditions	NONE

LATEST NEWS

MORE

Select source: Regulatory

- Collaboration with the Oxford Stone Group 13 Apr 15
- Half Yearly Report 13 Feb 15
- Result of AGM 20 Nov 14
- Posting of Report & Accounts and Notice of AGM 30 Oct 14
- Final Results 28 Oct 14

COMPANY INFORMATION

Updated Monthly

Company address	Unit 5, Grange Park, Broadway, Bourn,, CB23 2TA, United Kingdom
Company website	http://www.fbk.com
Market cap(in millions)*	£ 3.15
Listing/Admission	

TexRAD Cancer Diagnostics using Biomarkers *iisp* & BSMS, [3], [4]

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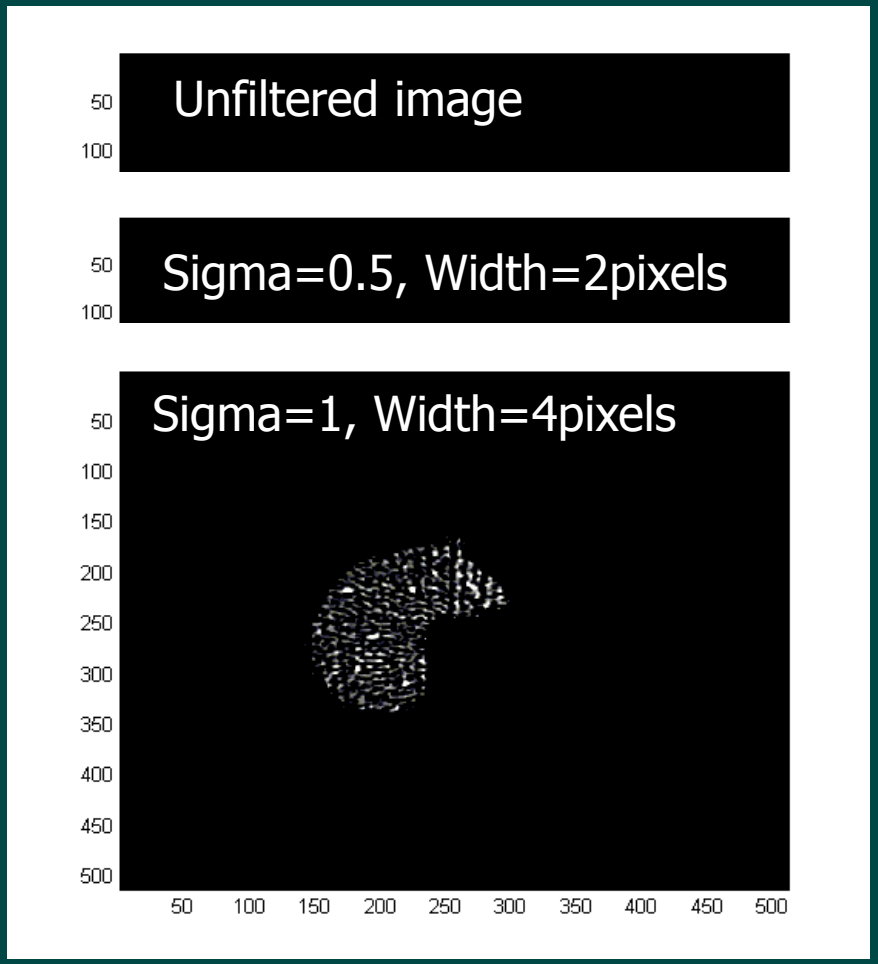

- LoG Filtered CT Liver Images

TexRAD Launch – 2011

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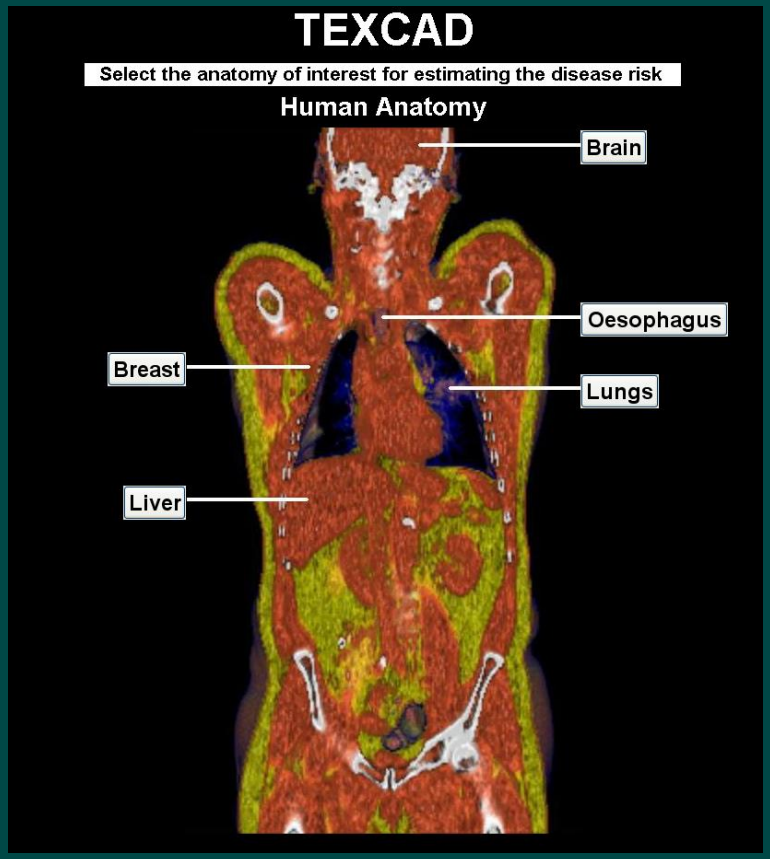
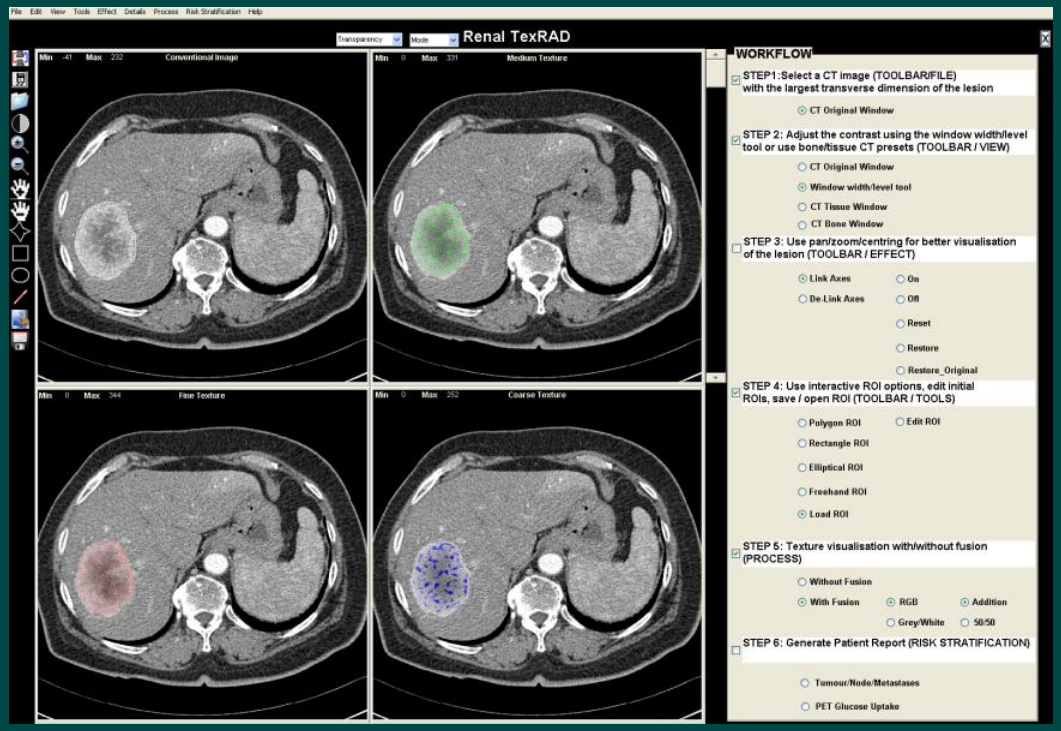


Renal Metastases Demo - Tyrosine Kinase Inhibitors

University of Sussex

TexRAD: Potential predictive imaging biomarker of response to treatment in metastatic renal cancer

TexRAD PRE-TREATMENT



Screenshot of the Renal TexRAD highlighting 'Right lobe liver' metastases *(pre-treatment)* on the conventional CT image (top-left), followed by the derived texture maps superimposed on the conventional CT image – fine (red), medium (green) and coarse (blue) texture

Renal Metastases Demo, [3], [4]

University of Sussex

TexRAD: Potential predictive imaging biomarker of response to treatment in metastatic renal cancer

TexRAD POST-TREATMENT

Screenshot of the Renal TexRAD highlighting 'Right lobe liver' metastases *(post-treatment)* on the conventional CT image (top-left), followed by the derived texture maps superimposed on the conventional CT image – fine (red), medium (green) and coarse (blue) texture

Fluorescence Light Sheet Microscope Schematic

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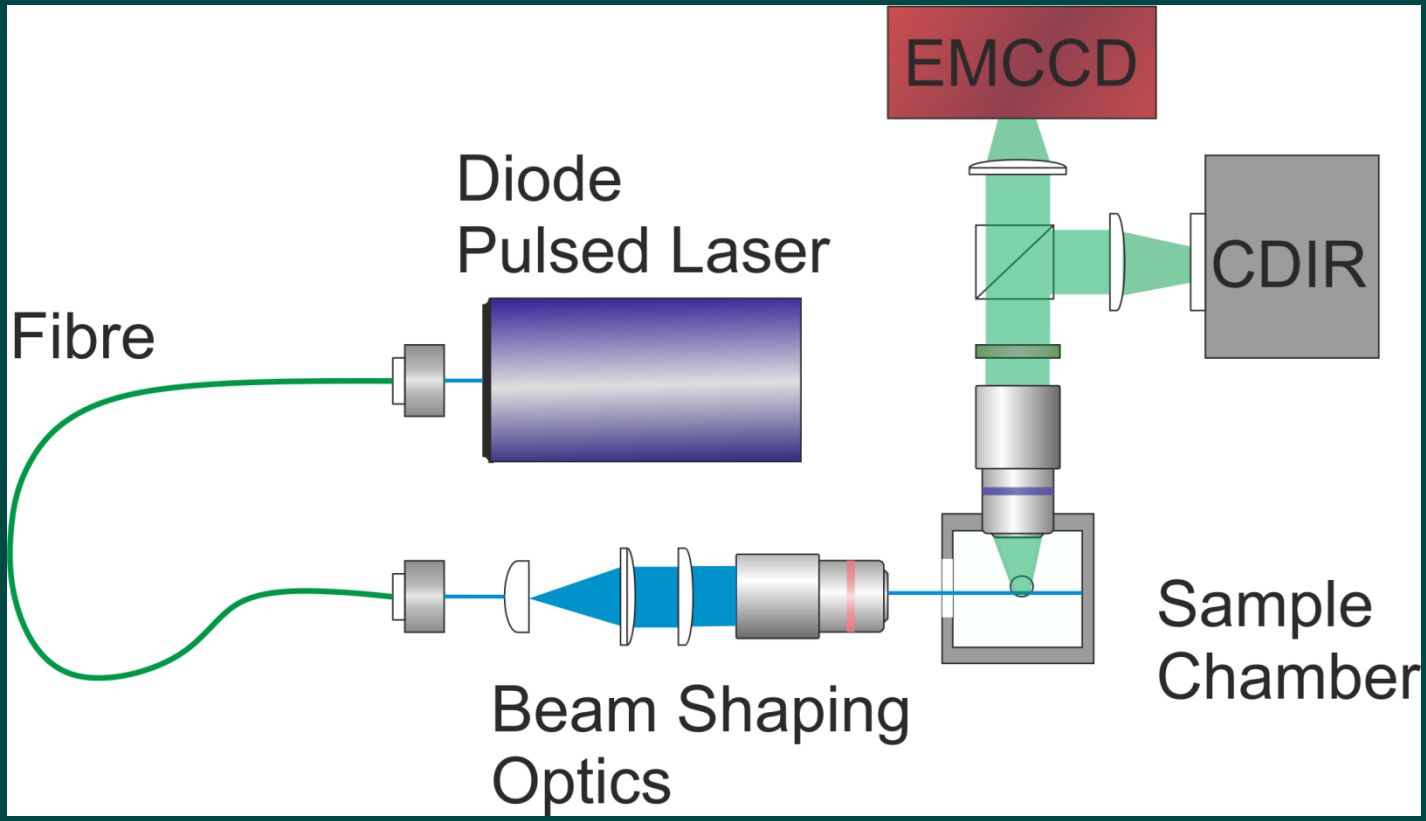
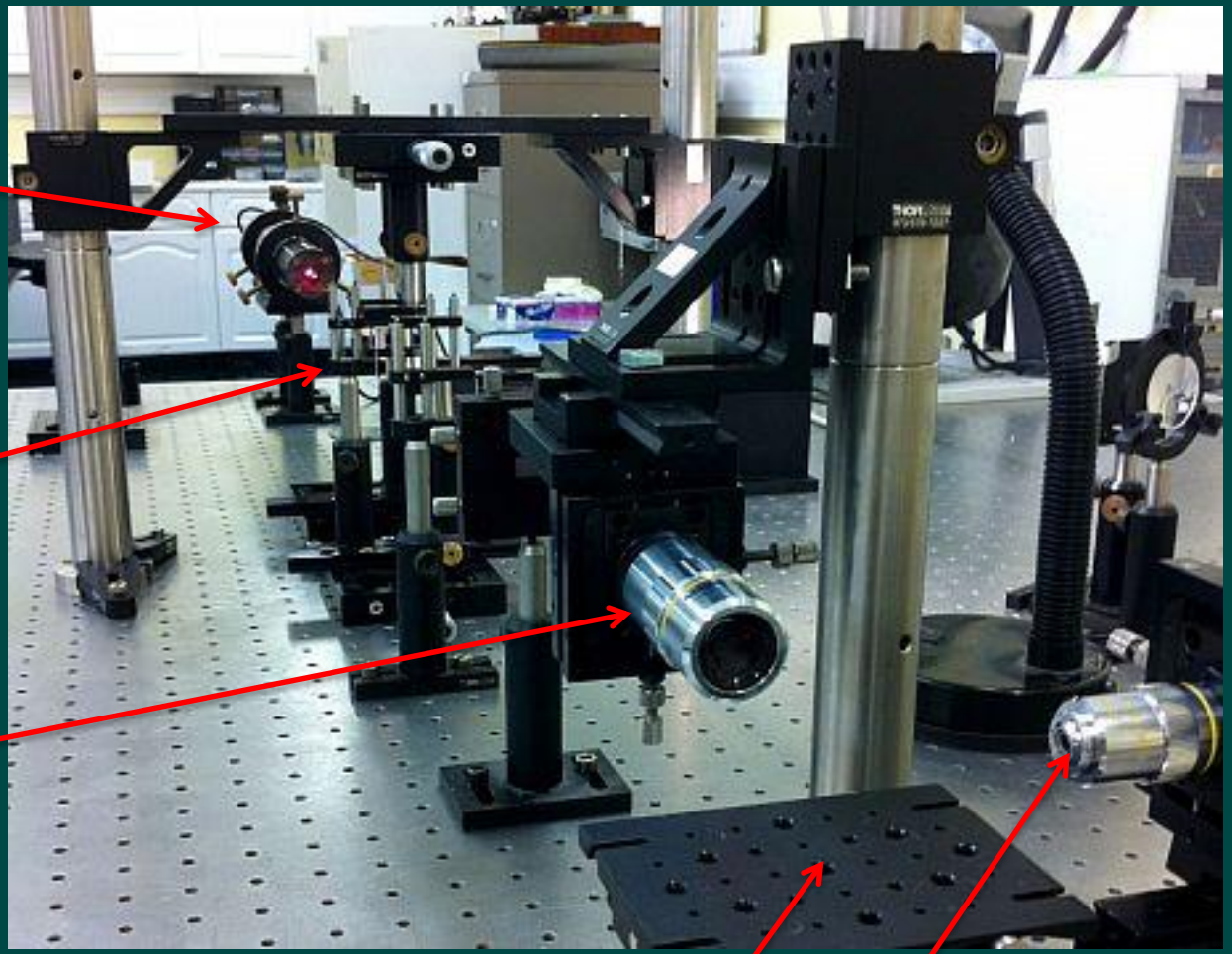


Fluorescence Light Sheet Microscope without sample chamber, [5]

University of Sussex



Imaging Fluorophores in a Fruit Fly's Heart, [6]

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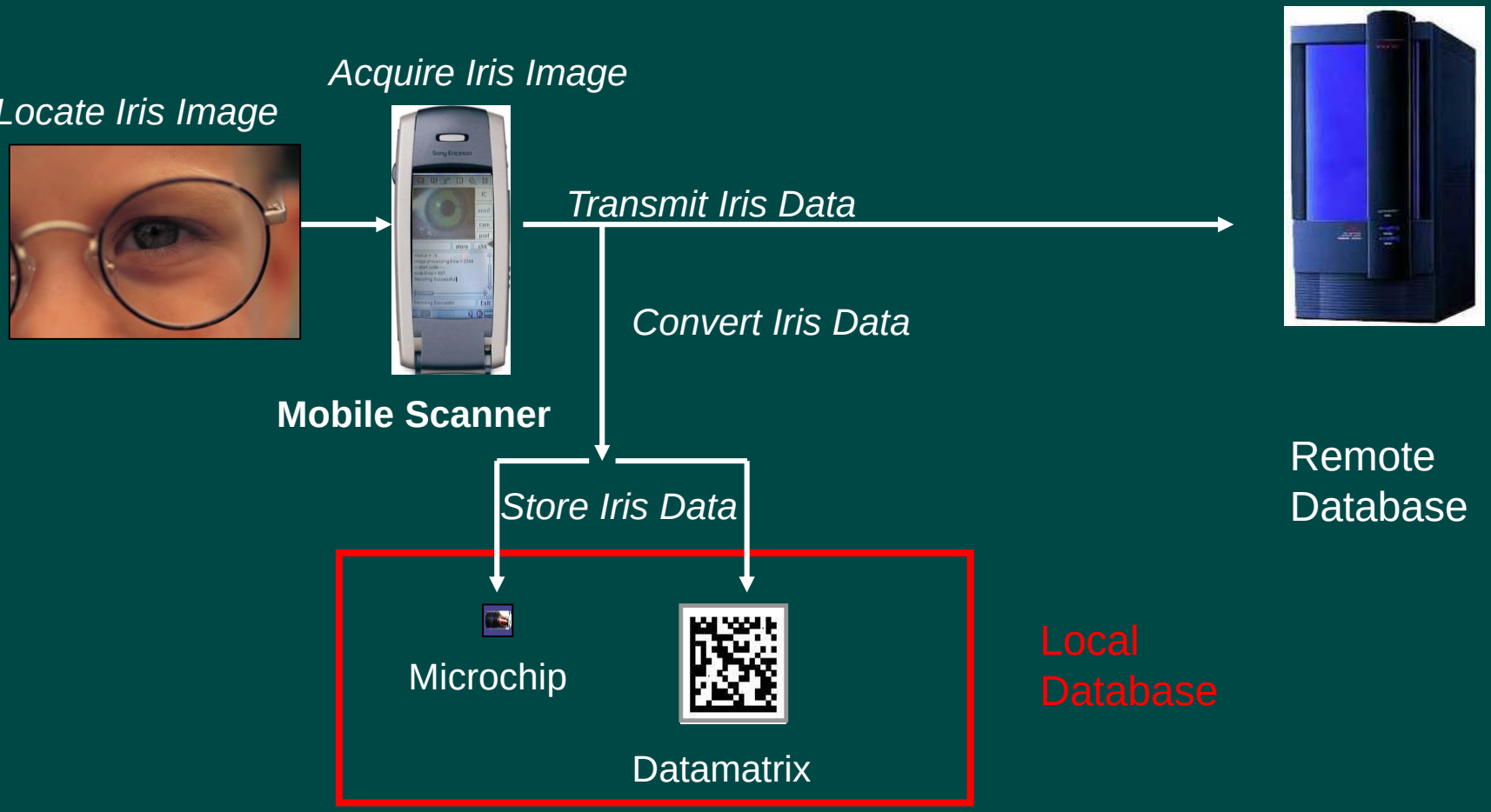
Mobile Iris Biometric ID System 2004- 2005 - industry funding, [7]

University of Sussex



Acquire & Convert Iris Biometric into Data

Mobile Iris Biometric ID System, [8]

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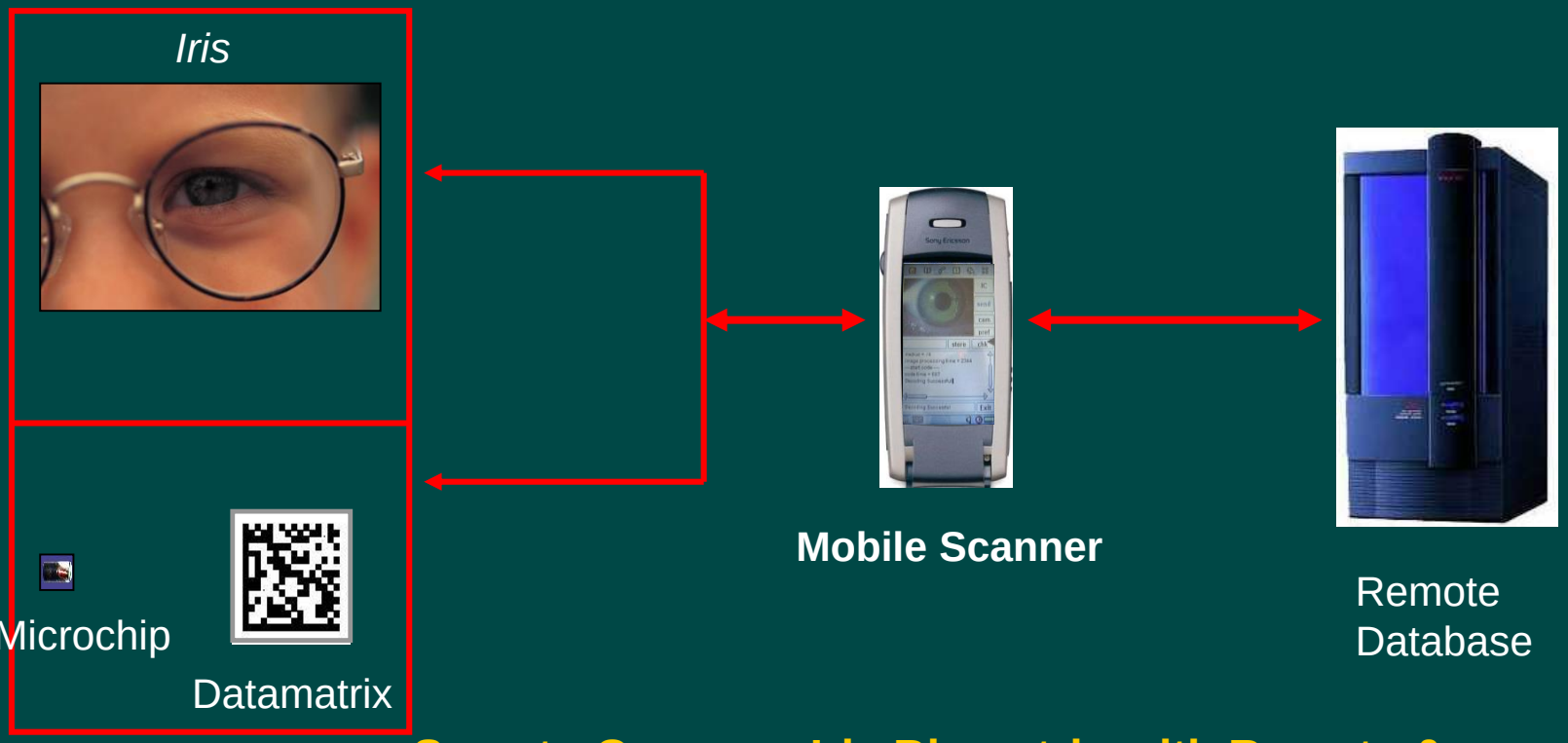

Scan to Compare Iris Biometric with Remote & Local Database (Iris/Microchip/Datamatrix)

Mobile Iris Biometric ID System

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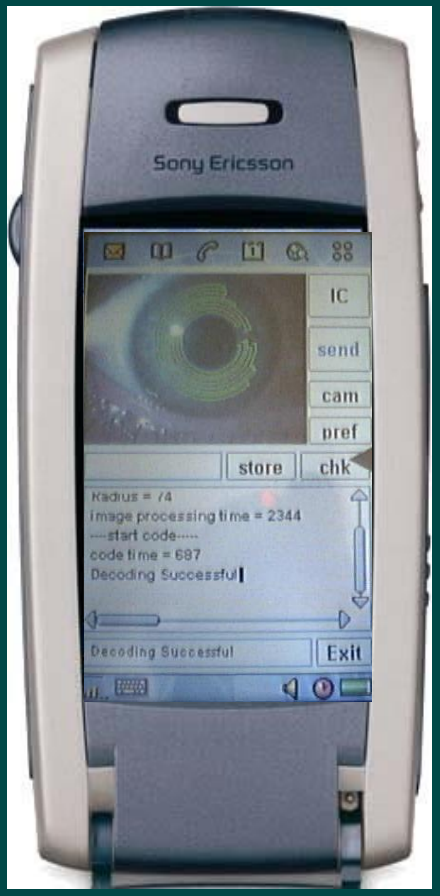
Camera View

Demonstrator Model



Display

Mobile Iris Biometric ID System

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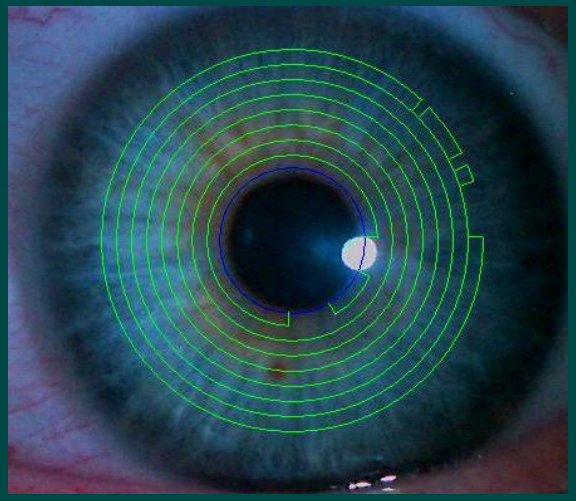
(a) Phone Screen Display

(b) Iris Captured for processing



(a) Screen display of successful Iris capture & processing less than 1 second.

(b) Captured image for processing with grid overlay

Vein pattern recognition hardware

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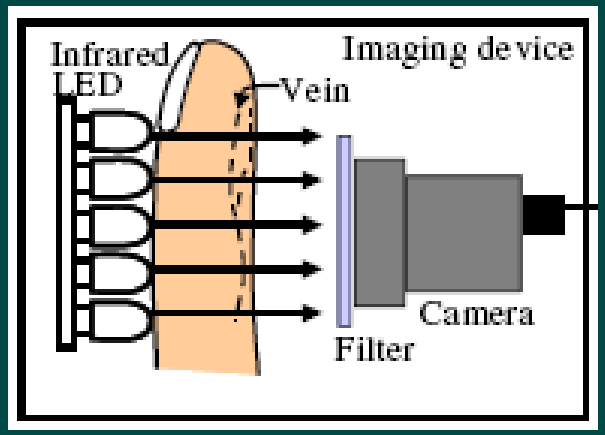
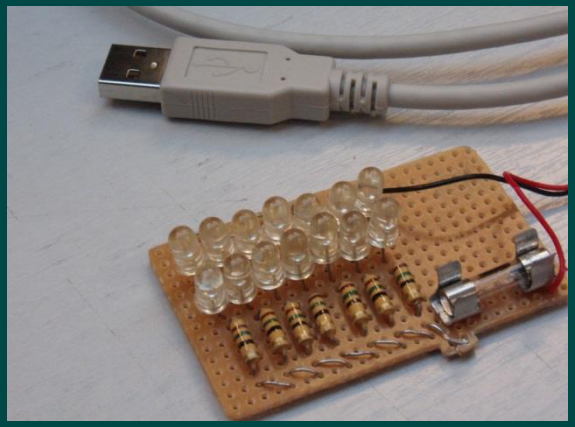
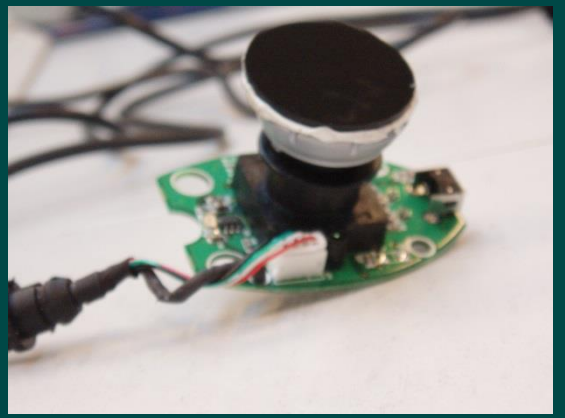


Finger placed on its dorsal side



14 Infrared LEDs with 810nm wavelength

USB powered (5V-500mA max)



CMOS webcam

Infrared (plastic) filter to cut-off visible light

Vein pattern image enhancement

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Image without using the infrared pass filter

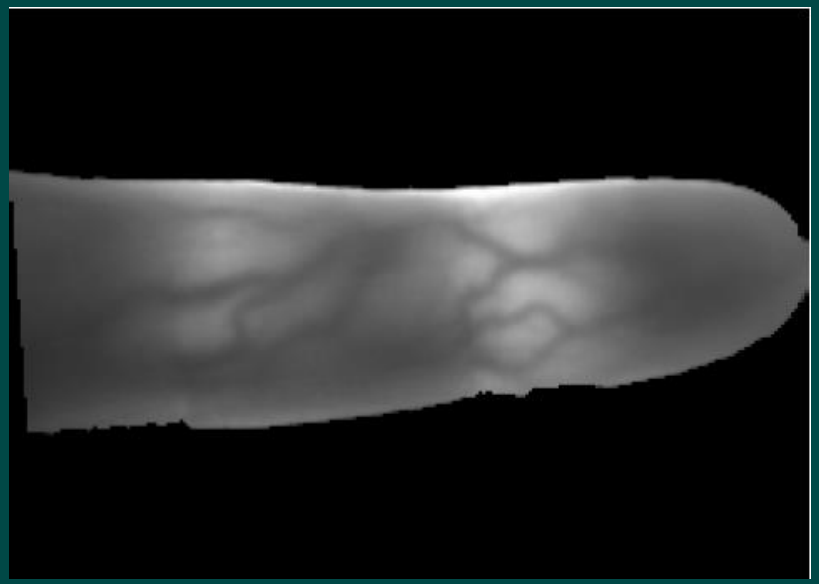

Image after using the pass filter

Vein pattern recognition software

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Captured Image

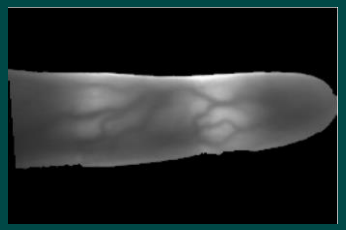
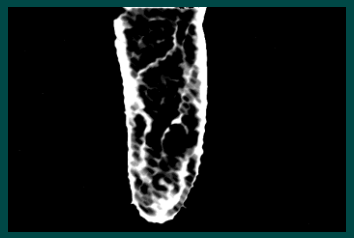


Image Conversion (RGB to Gray)

Image Enhancement

DoG Filter



Edge Elimination

Processed Image

Database Images

SDF Filter

Identification

Image Resolution

320 x 240

Vein pattern recognition software

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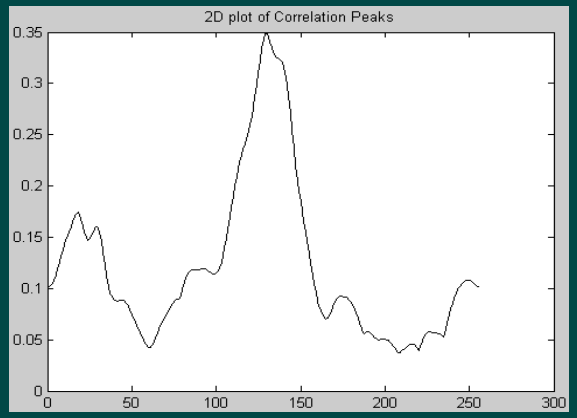
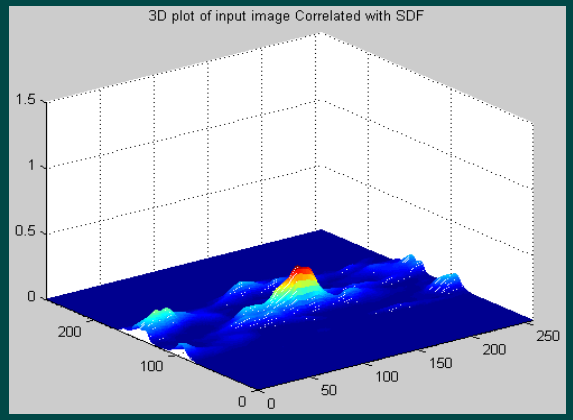
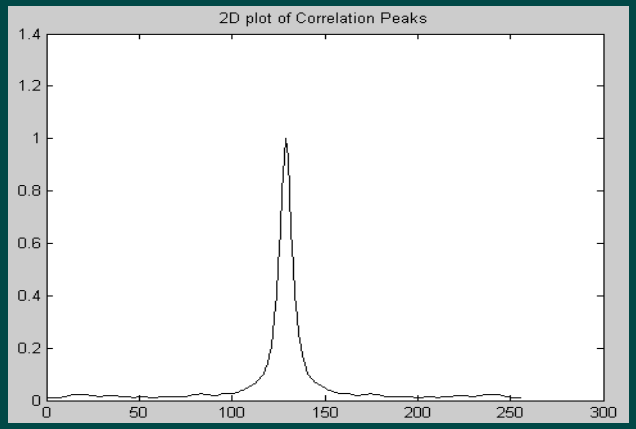
When the Synthetic Discriminant Function (SDF) filter is applied to the image then the identification process occurs.

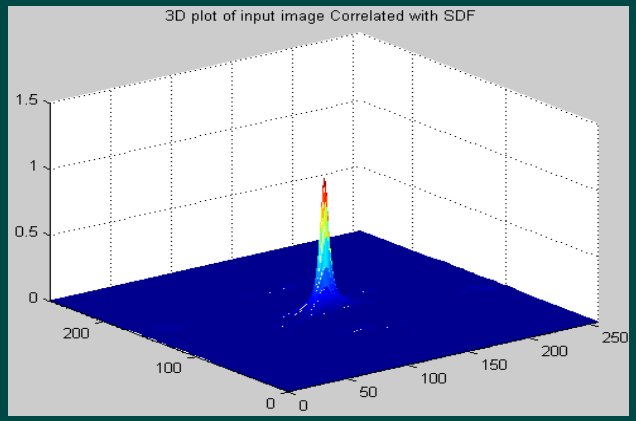
Vein pattern not identified (threshold 0.35)





Vein pattern identified (threshold 1)





Security – Tracking DSTL

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- User selects object
- Algorithms tracks it
  - Must cope with
    - Scale
    - Rotation
    - Occlusions
    - Lighting
    - Clutter

The OT-MACH Tracker - Features

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- Optimal Trade-off Maximum Amplitude Correlation Height (OT-MACH) filter used as a robust tracker.
- Scale, Orientation and Velocity invariant robust tracker.
- Performs in real-time on both colour (visible) and infra-red band scenarios.
- Conveniently trainable for real-time target tracking applications.
- Dynamic filter updatability, making the algorithm robust for tracking.

Filter Initialization

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- User interface developed for selecting a target in run-time
- Three types of user selection designed and tested
  - Rectangular
  - Circular
  - Assisted active contour
- Rectangular and Circular target selection found to be less accurate compared to active contour based selection
- The filter function is developed for three different scales of the target after scaling the selected target.

Target selection methods

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Rectangular

Circular

Active Contour

Active Contour Target Reference

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- Active contour selected target used to create a blank background reference image
- The reference image is rotated -6 to +6 degrees and 7 reference images are created (2 deg increments)
- The reference images are scaled for three different scales and triple filter function bank computed.
- A rotationally multiplexed OT-MACH filter is then created using the reference image sets.

Active contour selected target reference

Real-time implementation of the OT-MACH tracker ,[9]

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- The filter is automatically updated selecting the current target every update interval set by the end-user (we did this every 25 frames for visible, every 5 frames for IR)
- Rotational multiplexing and triple filter bank increases tolerance of the filter to changes in target orientation and scale changes
- The maximum correlation height values are used to estimate if a filter update is possible or not in the next update interval
- A threshold of 85% of the maximum height value is used to locate the target

Example result and correlation plot

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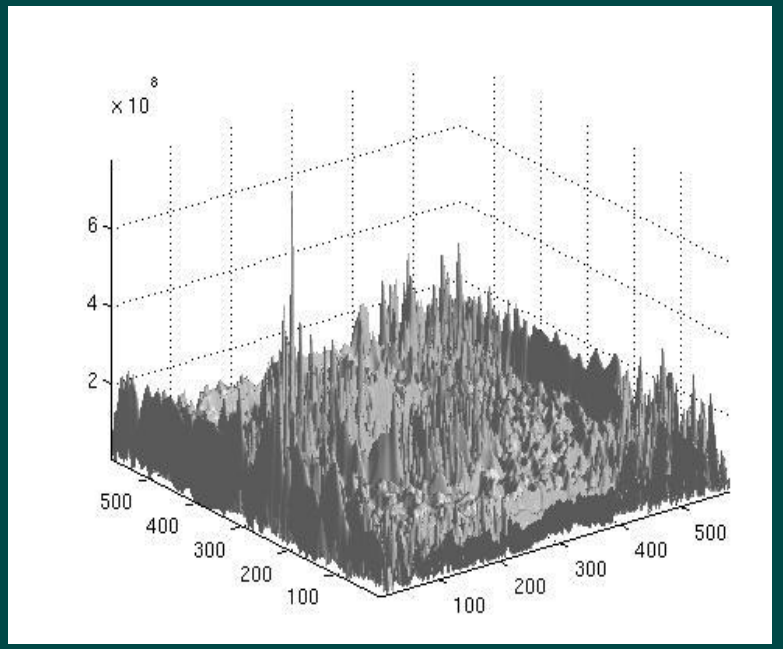
Cross-hair on target

Correlation plot



Kalman filter limitations

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- Unlike the OT-MACH tracker, the Kalman filter method is not a suitable estimator for noisy frames, varying velocity targets and extreme scale changes
- A colour based particle filter method was also investigated and compared with the OT-MACH tracker

Kalman filter to distinguish between target and non-targets

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Kalman filter(red) and OT-MACH tracker(yellow) result

Colour based Particle filter to distinguish between target and non-targets, [10]

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Particle filter(blue particles and red tracking) and OT-MACH tracker(yellow) result

OT-MACH tracker results

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Blurred Video of Truck OT - MACH

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Gaussian blurring 7x7 kernel, sigma = 2.0

Salt and pepper noise (45% noise) results

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